Smart Interface of HEAT: Hayabusa2 Exploration Assistant for TIR

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The Hayabusa2 project is a sample return mission to the asteroid Ryugu. It was launched on Dec. 3, 2014, and it has been at Ryugu since June 27, 2018. Hayabusa2 has optical instrument called Thermal Infrared Imager (TIR). These main functions are to know natures of the asteroid and to select the candidate of safe landing sites for sampling based on thermos-physical properties of the surface. TIR records infrared radiation from the target as a digital number (DN). The infrared signal is affected by sensor-surrounding objects; lens, shutter, package, and case. TIR requires consideration about this effect when converts DN images to temperature one. This study improved conversion system to increase conversion efficiency.

Hayabusa2 TIR Science Team has developed an analysis supporting tool called Hayabusa2 Exploration Assistant for TIR (HEAT). HEAT is used to search TIR data interactively, display TIR images, and visualize thermal models. We receive TIR raw images (Product Level 1) from ISAS/JAXA and convert them to brightness temperature images (Level 2a) and radiance images (Level 2b) using HEAT at Univ. of Aizu. The converted images are provided to the Hayabusa2 project data server.

This part introduces a concept model. The spectral radiance emitted from a blackbody B(λ,T) (W s r-1m-2) is given by the Planck function based on wavelength λ (m) and temperature T(K) as follows:

$$B(\lambda,T) = (2hc2/\lambda 5)* (1/(\exp(\lambda kBT)-1))$$

H = 6.63*1034 (m2 kg s-2 s-1) is the Planck constant, c=2.9972*108(ms-1) is the speed of light, and KB= 1.38*10-23 (m2 kg s-2K-1) is the Boltzmann constant. The observed radiance L(T) (W sr−1 m−2) is as follows:

$$L(T)= \varepsilon \int BR(\lambda)d\lambda$$

ε is the spectral thermal emissivity, and R(λ) is the response function such as the detection efficiency of the bolometer, the measured transmittance of optics including the band-pass filter and the germanium lens. The calibration formula with two regressed parameters A and B is written as follows:

$$DN=A * L(T) + B$$

The converted temperatures of the Moon were lower than expected because each pixel did not cover the sunlit area entirely or due to roughness effect of the cratered terrain. TIR has been observing Ryugu in

approach and rendezvous phases. The altitudes of TIR observations during the rendezvous phase range from 20 km to less than 10 m. This study has processed about 3000 Ryugu images observed by TIR since June 2018.

This study improved conversion system. Previous conversion system converts a TIR image one by one, but current conversion system converts TIR images in selected directory at once.

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